METHOD FOR CONTROLLING PILOT POWER
OF A CELL WITHIN A CDMA SYSTEM

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FIELD OF THE INVENTION

The present invention generally relates to the field of communication systems. More specifically, the invention relates to a control of pilot power within a Code-Division Multiple Access (CDMA) system.

10   ## BACKGROUND OF THE INVENTION

Code-Division Multiple Access (CDMA) is a well-known spread-spectrum physical layer technology for cellular systems. Performance in a CDMA network is strongly affected by the traffic load and the user distribution per cell within the CDMA network. Typically, the pilot powers of

15   each cell within the CDMA network are designed based upon expected traffic loads and measured fading conditions in the field. The pilot powers are then kept constant irrespective of any significant variance in traffic loads and/or fading conditions over time. The result can be a substandard performance of the CDMA network in terms of call drops during significant variations in traffic

20   loads and/or fading condition.

Therefore, it would be desirable to have an adaptive pilot power control to improve the performance of the CDMA network under actual conditions.

SUMMARY OF THE INVENTION

25   One form of the invention is a method for controlling a pilot power of a cell within a CDMA network. First, a transcoder loss per frame within the cell is determined. Second, a cell performance ~~matrix~~ metric of the cell is computed when the transcoder loss per frame is equal to or greater than a threshold value. The pilot power is controlled as a function of the cell

30   performance ~~matrix~~ metric.

A second form of the invention is a CDMA network comprising a cell and a base station. The base station is operable to determine a transcoder loss per frame within the cell. The base station is further operable to compute

a cell performance ~~matrix~~ metric of the cell when the transcoder loss per frame is equal to or greater than a threshold value.

A third form of the invention is a CDMA network comprising a cell, means for determining a transcoder loss per frame within the cell, and means

5   for computing a cell performance ~~matrix~~ metric of the cell when the transcoder loss per frame is equal to or greater than a threshold value.

A fourth form of the present invention is a computer readable medium storing a computer program for controlling a pilot power of a cell within a CDMA network. The computer readable medium comprises means for

10   determining a transcoder loss per frame within the cell, and computer readable code for computing a cell performance ~~matrix~~ metric of the cell when the transcoder loss per frame is equal to or greater than a threshold value.

The foregoing and other features and advantages of the invention will become further apparent from the following detailed description of the

15   presently preferred embodiment, read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the invention rather than limiting, the scope of the invention being defined by the appended claims and equivalents thereof.

20   BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an overview diagram of one embodiment of a cellular pattern of a CDMA network in accordance with the present invention;

FIG. 2 is a block diagram illustrating one embodiment of a home cell of the CDMA network of FIG. 1 in accordance with the present invention; and

25   FIG. 3 is a flowchart illustrating one embodiment of a method for controlling pilot power within the CDMA network of FIG. 1 in accordance with the present invention.

DETAILED DESCRIPTION OF THE
30   PRESENTLY PREFERRED EMBODIMENTS

FIG. 1 illustrates a cellular pattern of a CDMA network 10 in accordance with one embodiment of the present invention. The cellular pattern includes a plurality of cells 11-29. Each cell 11-29 has neighboring

cells forming a cell cluster. The following TABLE 1 lists each cell and its corresponding cell cluster:

TABLE 1

CELL	CELL CLUSTER
11	12-17
12	11, 13, 17-19, 29
13	11, 12, 14, 19-21
14	11, 13, 15, 21-23
15	11, 14, 16, 23-25
16	11, 15, 17, 25-27
17	11, 12, 16, 27-29
18	12, 19, 29
19	12, 13, 18, 20
20	13, 19, 21
21	13, 14, 20, 22
22	14, 21, 23
23	14, 15, 22, 24
24	15, 23, 25
25	15, 16, 24, 26
26	16, 25, 27
27	16, 17, 26, 28
28	17, 27, 29
29	12, 17, 18, 28

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Each cell 11-29 includes a base station (not shown) having conventional hardware and software for providing communication service within the corresponding cell. A description of the conventional hardware and

10   software is not provided herein. However, those having ordinary skill in the art will appreciate various conventional methods and devices implemented by the base stations to measure a cell power, a traffic, a frame erasure, a plurality of frames, a transcoder loss per frame, a transcoder loss uplink, a

transcoder loss downlink, and an average energy per chip per interference density measured on the pilot channel associated with the corresponding cell.

FIG. 2 illustrates the home cell 11 in accordance with one embodiment of the present invention. The home cell 11 includes a base station 11a. In

5   addition to the aforementioned conventional hardware and software, the base station 11a includes hardware, software or a combination of hardware and software for controlling a pilot power of each cell 11-29 within the CDMA network 10 in accordance with the present invention. FIG. 3 illustrates a flowchart 30 that is representative of a method for controlling a pilot power of

10   each cell 11-29 within the CDMA network 10 that is implemented by the base station 11a. In one embodiment, the base station 11a executes the flowchart 30 for each cell 11-29 over a fixed time interval (e.g., every 8 seconds). The flowchart 30 will now be described herein in the context of an execution of the flowchart 30 for the home cell 11.

15   During a stage S32 of the flowchart 30, the base station 11a determines if a transcoder loss per frame of the home cell 11 is less than a threshold value established by actual operational parameters of the CDMA network 10 as would be appreciated by those having ordinary skill in the art. If the base station 11a determines the transcoder loss per frame of the home

20   cell 11 is less than the threshold value, the base station 11a proceeds to terminate the flowchart 30. As a result, the pilot power of the home cell 11 remains constant.

If the base station 11a determines the transcoder loss per frame of the home cell 11 is equal to or greater than the threshold value, the base station

25   11a proceeds to a stage S34 of the flowchart 30 to compute a cell performance metric for the home cell 11 and a cluster performance ~~matrix~~ metric for the cell cluster associated with the home cell 11. In one embodiment, the cell performance metric of the cell 11 is computed in accordance with the following equation [1]:

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$$CellPerformanceMetric_{11} = \left(\frac{CP_{11}}{T_{11}}\right) \times \left(\frac{FE_{11}}{F_{11}}\right) \times \left(\frac{TLU_{11}}{TLD_{11}}\right) \times \left(\frac{Ec}{Io}\ Average_{11}\right)$$

[1]

In equation [1], CP_{11} is a measured cell power of the home cell **11**, T_{11} is a measured traffic of the home cell **11**, FE_{11} is a measured frame erasure of the home cell **11**, F_{11} is a measured number of frames of the home cell **11**, TLU_{11} is a measured transcoder loss uplink of the home cell **11**, TLD_{11} is a

5   measured transcoder loss downlink of the home cell **11**, and $Ec/Io\ Average_{11}$ is measured energy per chip per interference density measured on the pilot channel of the home cell **11**. The $Ec/Io\ Average_{11}$ can be based upon a Pilot Strength Measurement Message and a Power Measurement Report Message received from each communication device (e.g., a mobile phone) attached to

10   the home cell **11**.

The cluster performance ~~matrix~~ <u>metric</u> is an average of a computation of each cell performance ~~matrix~~ <u>metric</u> of each cell within the cluster. Thus, the base station **11a** would communicate with the base stations of the cell cluster **12-17** to obtain the necessary measured parameters for the following

15   equations [2]-[7]:

$$CellPerformanceMetric_{12} = \left(\frac{CP_{12}}{T_{12}}\right) \times \left(\frac{FE_{12}}{F_{12}}\right) \times \left(\frac{TLU_{12}}{TLD_{12}}\right) \times \left(\frac{Ec}{Io} Average_{12}\right)$$

[2]

20   In equation [2], CP_{12} is a measured cell power of the home cell **12**, T_{12} is a measured traffic of the home cell **12**, FE_{12} is a measured frame erasure of the home cell **12**, F_{12} is a measured number of frames of the home cell **12**, TLU_{12} is a measured transcoder loss uplink of the home cell **12**, TLD_{12} is a measured transcoder loss downlink of the home cell **12**, and $Ec/Io\ Average_{12}$

25   is measured energy per chip per interference density measured on the pilot channel of the home cell **12**. The $Ec/Io\ Average_{12}$ can be based upon a Pilot Strength Measurement Message and a Power Measurement Report Message received from each communication device (e.g., a mobile phone) attached to the home cell **12**.

30   $$CellPerformanceMetric_{13} = \left(\frac{CP_{13}}{T_{13}}\right) \times \left(\frac{FE_{13}}{F_{13}}\right) \times \left(\frac{TLU_{13}}{TLD_{13}}\right) \times \left(\frac{Ec}{Io} Average_{13}\right)$$

[3]

In equation [3], CP_{13} is a measured cell power of the home cell **13**, T_{13}
is a measured traffic of the home cell **13**, FE_{13} is a measured frame erasure of
the home cell **13**, F_{13} is a measured number of frames of the home cell **13**,
TLU_{13} is a measured transcoder loss uplink of the home cell **13**, TLD_{13} is a

5   measured transcoder loss downlink of the home cell **13**, and $Ec/Io\ Average_{13}$
is measured energy per chip per interference density measured on the pilot
channel of the home cell **13**. The $Ec/Io\ Average_{13}$ can be based upon a Pilot
Strength Measurement Message and a Power Measurement Report Message
received from each communication device (e.g., a mobile phone) attached to

10   the home cell **13**.

$$CellPerformanceMetric_{14} = \left(\frac{CP_{14}}{T_{14}}\right) \times \left(\frac{FE_{14}}{F_{14}}\right) \times \left(\frac{TLU_{14}}{TLD_{14}}\right) \times \left(\frac{Ec}{Io}\ Average_{14}\right)$$

[4]

15   In equation [4], CP_{14} is a measured cell power of the home cell **14**, T_{14}
is a measured traffic of the home cell **14**, FE_{14} is a measured frame erasure of
the home cell **14**, F_{14} is a measured number of frames of the home cell **14**,
TLU_{14} is a measured transcoder loss uplink of the home cell **14**, TLD_{14} is a
measured transcoder loss downlink of the home cell **14**, and $Ec/Io\ Average_{14}$

20   is measured energy per chip per interference density measured on the pilot
channel of the home cell **14**. The $Ec/Io\ Average_{14}$ can be based upon a Pilot
Strength Measurement Message and a Power Measurement Report Message
received from each communication device (e.g., a mobile phone) attached to
the home cell **14**.

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$$CellPerformanceMetric_{15} = \left(\frac{CP_{15}}{T_{15}}\right) \times \left(\frac{FE_{15}}{F_{15}}\right) \times \left(\frac{TLU_{15}}{TLD_{15}}\right) \times \left(\frac{Ec}{Io}\ Average_{15}\right)$$

[5]

In equation [5], CP_{15} is a measured cell power of the home cell **15**, T_{15}
is a measured traffic of the home cell **15**, FE_{15} is a measured frame erasure of

30   the home cell **15**, F_{15} is a measured number of frames of the home cell **15**,
TLU_{15} is a measured transcoder loss uplink of the home cell **15**, TLD_{15} is a
measured transcoder loss downlink of the home cell **15**, and $Ec/Io\ Average_{15}$

is measured energy per chip per interference density measured on the pilot channel of the home cell **15**. The *Ec/Io Average₁₅* can be based upon a Pilot Strength Measurement Message and a Power Measurement Report Message received from each communication device (e.g., a mobile phone) attached to

5   the home cell **15**.

$$CellPerformanceMetric_{16} = \left(\frac{CP_{16}}{T_{16}}\right) \times \left(\frac{FE_{16}}{F_{16}}\right) \times \left(\frac{TLU_{16}}{TLD_{16}}\right) \times \left(\frac{Ec}{Io} Average_{16}\right)$$

[6]

10   In equation [6], CP_{16} is a measured cell power of the home cell **16**, T_{16} is a measured traffic of the home cell **16**, FE_{16} is a measured frame erasure of the home cell **16**, F_{16} is a measured number of frames of the home cell **16**, TLU_{16} is a measured transcoder loss uplink of the home cell **16**, TLD_{16} is a measured transcoder loss downlink of the home cell **16**, and Ec/Io $Average_{16}$

15   is measured energy per chip per interference density measured on the pilot channel of the home cell **16**. The *Ec/Io Average₁₆* can be based upon a Pilot Strength Measurement Message and a Power Measurement Report Message received from each communication device (e.g., a mobile phone) attached to the home cell **16**.

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$$CellPerformanceMetric_{17} = \left(\frac{CP_{17}}{T_{17}}\right) \times \left(\frac{FE_{17}}{F_{17}}\right) \times \left(\frac{TLU_{17}}{TLD_{17}}\right) \times \left(\frac{Ec}{Io} Average_{17}\right)$$

[7]

In equation [7], CP_{17} is a measured cell power of the home cell **17**, T_{17}

25   is a measured traffic of the home cell **17**, FE_{17} is a measured frame erasure of the home cell **17**, F_{17} is a measured number of frames of the home cell **17**, TLU_{17} is a measured transcoder loss uplink of the home cell **17**, TLD_{17} is a measured transcoder loss downlink of the home cell **17**, and Ec/Io $Average_{17}$ is measured energy per chip per interference density measured on the pilot

30   channel of the home cell **17**. The *Ec/Io Average₁₇* can be based upon a Pilot Strength Measurement Message and a Power Measurement Report Message

received from each communication device (e.g., a mobile phone) attached to the home cell **17**.

Upon receipt of the aforementioned parameters, the base station **11a** computes a cell performance ~~matrix~~ metric for each cell **12-17**, and then
5   averages the computed cell performance ~~matrix~~ metrices to obtain the cluster performance ~~matrix~~ metric.

Upon computing the cell performance ~~matrix~~ metric of the cell **11** and the cluster performance ~~matrix~~ metric of the cell cluster **12-17**, the base station **11a** proceeds to a stage **S36** of the flowchart **30** to determine if the cell
10   performance ~~matrix~~ metric is less than the cluster performance ~~matrix~~ metric. When the base station **11a** determines the cell performance ~~matrix~~ metric is less than the cluster performance ~~matrix~~ metric, the base station **11a** proceeds to a stage **S38** of the flowchart **30** to conditionally decrease the pilot power of the home cell **11**. Otherwise, the base station **11a** proceeds to a
15   stage **S40** of the flowchart **30** to conditionally increase the pilot power of the home cell **11**.

In one embodiment, the home cell **11** is designed with a minimum level and a maximum level for the pilot power of the home cell **11** that are established by actual operational parameters of the CDMA network **10** as
20   would be appreciated by those having ordinary skill in the art. During stage **S38** of the flowchart **30**, the following condition [8] must be satisfied before the pilot power of the home cell **11** is decreased:

$$PP_{CURRENT} - X \geq PP_{MINIMUM}$$

25   [8]

In condition [8], $PP_{CURRENT}$ is the current level of the pilot power of the home cell **11**, X is a number that is either a fixed decrement, a variable
30   decrement, or a decrement equal to a percentage of the current level of the pilot power $PP_{CURRENT}$, and $PP_{MINIMUM}$ is the minimum level established for the pilot power of the home cell **11**. When the condition [8] is satisfied, the current level of the pilot power $PP_{CURRENT}$ is decreased by X.